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# THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

## Develop Portable Hazardous Duty Lighting for Shipbuilding Surface Preparation and Coating

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
Halter Marine Group, Inc.

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National Shipbuilding Research Program Project
Number 3-96-5

# DEVELOP PORTABLE HAZARDOUS DUTY LIGHTING FOR SHIPBUILDING SUFACE PREPARATION AND COATING

# FINAL REPORT

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December 22, 2000

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Develop Portable Hazardous Duty Lighting For Shipbuilding Surface Preparation and Coating

## SUMMARY OF PROJECT OPERATIONS

The primary objective of this project was to develop a hazardous duty classified area lighting system for use during the application of coatings within the shipbuilding industry. This was accomplished with a multi –stage project. We first determined what lighting systems where currently in use, what worked and what didn't, and for what applications. We interpreted the information and designed a lighting system that would be easy to maintain, extremely durable, produce clear white light, offer exceptional safety, productivity, maximum flexibility, and cost effectiveness. We believe we have succeeded on all counts.

## RESULTS

This project has resulted in a total of 3 different fixtures being designed. The first is the explosion proof model which we were contracted to build and the other two are variations designed for more general applications. This allows the user to extend the application of the primary design criteria.

## COMPLETE PRODUCT DISCUSSION

Our original design criteria required a light system capable of being used in both severe (blasting) and hazardous (coating) environments. This is the light we had tested at Applied Research Laboratory (ARL) under UL test procedures. This light has 120 VAC input with each "Light Box" having a 12 volt transformer installed inside the fixture making the fixture low voltage. Each fixture is equipped with a safety circuit interrupter based on our proprietary circuit technology. This fixture sports the daisy chain design which allows up to 10 fixtures to be plugged into each other.

For severe duty only (no hazardous environments) we will offer a "Standard Service" system. This system will operate much the same as the explosion proof model, but will not have a safety circuit interrupter and will not be a tested unit.

Our 3rd version is designed to operate one light box. This will plug into 120 volt outside the workspace and have a 12 volt power pack mounted outside the workspace. This system is designed for wet work such as hydro blasting, water washing and general dry dock work.

Since each of these systems will look alike, we will make the tower assemblies different colors and include distinctively different labels. However, many of the major components will be interchangeable, i.e., light bulb, globe, wiring collars, dust caps and lamp holders.

## SHIPYARD SURVEY

Thirteen shipyards were requested to participate in this survey and were assured of the confidentiality of the information given. All of the shipyards were faxed a six-page questionnaire asking them to identify the existing light fixtures used in tank cleaning, tank rigging, abrasive blasting, painting and temporary area lighting. The questionnaire was followed by a telephone interview to facilitate the process. At least three calls were made to each yard. Seven participated, while six chose not to participate for various reasons. In few of the surveys did all sections receive answers. In addition, concerns on the part of the shipyard personnel about liability if faulty systems were reported and defensiveness about their operations likely influenced the responses to the survey. A list of lights used for the five shipyard jobs in the survey are given in Appendix A.

The seven yards who responded provided the answers to specific questions and offered explanations. In some cases, the answers marked on a simple yes/no checklist conflicted with what respondents actually said about their lighting systems. For example, although all indicated "yes" on the checklist that their systems were durable and reliable, as they discussed in more detail their experiences, all respondents complained about easy bulb breakage and the lack of reliability. Others complained about lost production time due to bulb breakage and poor visibility during painting because of over spray covering globes. One respondent summed up his perspective on lighting by saying he was "embarrassed" by what his yard was using.

Respondents identified a variety of problems with their lighting systems: lost production time due to bulb breakage, frequent bulb burn out, poor visibility during painting due to over spray covering the globe, frequent cleaning requirements, difficulties in cleaning globes, inadequate illumination, poor durability, and lack of a disconnect for power cords.

In summary, the survey supported the need for the development of a lightweight, easy to use, bright, low voltage lighting system that could withstand the frequent handling and dirty conditions common to a typical blasting and painting environment in a shipyard.

Specific data from the checklist is reported in Appendix B.

Appendix A

Lights Currently in Use in Selected U.S. Shipyards

| Generic | Manufacturer | Models |
|---|---|---|
| | **Tank Cleaning** | |
| Floodlight | Hubbell | SLS-100th 040 |
| Portable 11-12v | Daniel Woodhead | Wet Location Light |
| Wheatlamp | Kohler | Series 510 |
| Metal Halide | Hubbell | 1000-H-040 |
| | Tank Rigging | |
| Site Lights | Western Technology | 4000 |
| Fluorescent Slimline | | C-248 |
| Stringers 100w | Duraline | |
| Basic Stringlights | | |
| | Abrasive Blasting | |
| Magnetic Area Lights | Western Technology | 4100-4210 |
| Hose-Mounted Lights | Western Technology | 3000 series |
| Portable Handheld | Daniel Woodhead | |
| Home made | | |
| | Painting | |
| Spray Light | Western Technology | 5000 Series |
| Portable Lamps | Stewart Brown | Exp-162 |
| Metal Halide 4000w | Codemaster | CMBH 400 MT |
| Temporary Area Lighting | | |
| Stringers | | |
| Flood Lights | | |

Market research turned up no new lighting applications. Research included extensive review of products offered through the Safety Marketing Group, which is a national group of independent distributors of safety products including hazardous duty lighting appliances, a review of lighting appliances listed in the Thomas Register, and a survey of U.S. Shipyards. This research was in part designed to determine if any new offerings were forthcoming from vendors. Nothing new from vendors was indicated.

Appendix B--Table of Responses to Survey of Selected U.S. Shipyards

| | Temp. Area Lighting | | Abrasive Blasting | | Tank Rigging | | Painting | | Tank Cleaning | |
|---|---|---|---|---|---|---|---|---|---|---|
| Category | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
| Hazardous Duty | 1 | 3 | 1 | 3 | 2 | 3 | 5 | 0 | 5 | 0 |
| Low Voltage (less than 24 V) | 0 | 4 | 3 | 1 | 0 | 4 | 2 | 3 | 2 | 3 |
| Battery Powered | 0 | 4 | 0 | 4 | 0 | 4 | 0 | 5 | 1 | 4 |
| Standard 120 V with GFI | 1 | 3 | 1 | 3 | 1 | 3 | 2 | 3 | 0 | 5 |
| Vapor Detection Interrupter | 0 | 4 | 0 | 4 | 1 | 4 | 2 | 3 | 1 | 4 |
| Hand Held | 2 | 2 | 2 | 2 | 0 | 4 | 4 | 1 | 1 | 4 |
| Stand Mounted | 4 | 0 | 4 | 0 | 3 | 1 | 2 | 3 | 1 | 4 |
| Magnetically Mounted | 0 | 4 | N/A | | N/A | | N/A | | N/A | |
| Blast Hose Mounted | N/A | | 3 | 1 | N/A | | N/A | | N/A | |
| String Configuration | 3 | 1 | 1 | 3 | 4 | 0 | 3 | 2 | 2 | 3 |
| Reliable/ Durable | 4 | 0 | 4 | 0 | 4 | 0 | 5 | 0 | 3 | 2 |
| Easy to Maintain/ Repair | 4 | 0 | 4 | 0 | 4 | 0 | 5 | 0 | 4 | 1 |
| Cost Effective/ Good Value | 4 | 0 | 4 | 0 | 3 | 0 | 5 | 0 | 3 | 1 |
| Produce Sufficient Illumination | N/A | | 4 | 0 | N/A | | 5 | 0 | N/A | |

REPORT OF MANUFACUTERS TESTING

The project was on schedule through the completion of the prototype. In-house testing supported that the critical proprietary components, such as the sensory circuit interrupter, worked flawlessly. The completed fixture exceeded our expectations regarding durability, light emission and serviceability.

However, a problem developed with the high intensity light bulb our engineers selected. A key design consideration for the "Light Box" was to use a standard lamp readily available from any commercial lighting supplier. A lamp from a major supplier was identified and selected, but during repetitive motion/vibration testing an unexpectedly high rate of failure was experienced. Different lamps exhibited different types of failure and many lamps were defective right out of their containers. The testing of the prototype revealed a reliability problem with the lamp selected.

Our efforts have always focused on improving the performance of our products. The setback with the lamp created the opportunity to review alternative lamps. The cost to Western Technology for any changes that require modification to the prototype mold is considerable. Yet, when actual testing of the new lamp led our engineer to determine that a superior result could be obtained by using a 12 volt lamp, we did it. These changes resulted in a change of the lamp socket, electronic circuit module and prototype molds to accommodate the 12 volt transformer.

The change in bulbs allowed Western Technology to provide a lamp resilient to the mechanical shock experienced during frequent handling of the "Light Box" without compromising the portability of the fixture as the input voltage remained 120 volts. In addition we have made the "Light Box" work without the sensory circuit interrupter module. This allows an operator to purchase a less expensive version of the "Light Box" for use in non-hazardous locations, making the system more versatile and cost effective.

ON SITE SHIPYARD TESTING RESULTS I & II

FIELD TEST I
LIGHT BOX PROTOTYPE NSRP CONTRACT 96-5-3
LOCATION: TODD SHIPYARD – SEATTLE, WA

DESCRIPTION OF APPLICATION: INSTALLATION OF THE "LIGHT BOX" IN THE MECHANICAL SPACE ON THE B&W MANN POWER GENERATION BARGE UNDER CONSTRUCTION AT TODD SHIPYARD – FINAL OUTFITTING STAGE. SPACE IS APPROXIMATELY 50' X 50' X 12' HIGH AND WAS COMPLETELY OUTFITTED.

ACTIVITY: PREPARE SURFACE FOR FINAL PAINTING OF BILGE, BULKHEADS AND STAIR WAY.

COATING: INTERNATIONAL PRIMER, RED EPOXY, KHA 303

TOP COAT INTERNATIONAL, WHITE, INTER SEAL 670

BOTH PRIMER AND TOPCOAT ARE SOLVENT BASED.

PERSONNEL INVOLVED: PETE JUDT – PAINT SUPERVISOR

ADMER HERNADES – PAINT LEADMAN

DAVID SHELDON – PAINT FOREMAN

INSTALLATION OF "LIGHT BOX" TOOK PLACE FRIDAY, MARCH 26, 1999 AT 1:15 P.M.

PAINTING WAS SCHEDULED THROUGHOUT THE WEEKEND.

THE "LIGHT BOX" WAS INSTALLED IN THE CENTER OF ONE QUADRANT OF

THE MECHANICAL SPACE, AND HOOKED OVER A PIPE APPROXIMATELY 18' ABOVE THE DECK.

GENERAL IMPRESSION BY PERSONNEL WORKING IN THE MECHANICAL SPACE:

- EASY TO INSTALL
- GOOD LEVEL OF ILLUMINATION
- LIKED THE "MODULAR" CONCEPT OF THE "LIGHT BOX"; THAT THE OPERATOR HAD THE OPTION TO SPACE THE "LIGHT BOX" FIXTURES AT VARIOUS INTERVALS AS TO WORK AROUND OBSTACLES IN THE WORK SPACE, OR GO INTO ADDITIONAL SPACES WITH A SINGLE POWER LINE.
- LIKED THE IDEA OF STANDARDIZING AN AREA LIGHT THAT IS EXPLOSION PROOF
- IMPRESSED WITH THE DURABILITY/RUBBER CONSTRUCTION/EASE OF ASSEMBLY/EASE OF CONNECTING FIXTURES TOGETHER
- "LIGHT BOX" STAYED COOL TO THE TOUCH
- LIKED THE IDEA OF POSSIBLY FREEING UP THE HANDS BY NOT HAVING TO DRAG A DROP LIGHT FIXTURE AROUND, INCREASING EFFICIENCY

THE "LIGHT BOX" WAS RELOCATED SEVERAL TIMES DURING THE COURSE OF THE PAINTING PROJECT; NO BULB BREAKAGE WAS EXPERIENCED.

WESTERN TECHNOLOGY PERSONNEL VISITED THE SITE SATURDAY AND SUNDAY. NO PROBLEMS WERE EXPERIENCED BY THE PAINTERS. WE ASKED THAT THE "LIGHT BOX" BE COMPLETELY EXPOSED DURING THE PAINTING OPERATION. THIS ALLOWED US TO TEST THE EFFECTIVENESS OF SPRAYING THE LIGHT WITH AN OIL TO PROTECT AGAINST PAINT ADHERING TO ITS SURFACE AND HOW BEST TO REMOVE THE PAINT IF IT

DID STICK. UPON CHECKING THE "LIGHT BOX" SUNDAY AFTERNOON, IT WAS OBVIOUS THAT THE OIL SELECTED WAS NOT WORKING. THE SOLVENT IN THE PAINT APPARENTLY BROKE DOWN THE OIL, AND AS EXPECTED, PAINT BUILT UP ON THE FIXTURES SURFACE. ILLUMINATION WAS REDUCED BUT DID NOT IMPAIR THE WORKERS SAFETY IN REGARDS TO VISIBILITY. EVEN THE MOST HEAVILY COATED SURFACE STILL ALLOWED ENOUGH LIGHT THROUGH TO MEASURE 12-FOOT CANDLES THROUGH THE SURFACE OF A CLEAN FIXTURE. THIS MEASUREMENT WAS TAKEN WITH A LIGHT METER MOUNTED ON A BULKHEAD, 6' AWAY FROM THE "LIGHT BOX". NOTE: (A LEVEL OF 10-FOOT CANDLES HAS BEEN PROPOSED AS AN ACCEPTABLE LEVEL OF GENERAL LIGHTING IN A TEMPORARY WORK SPACES BY THE SSPC LIGHTING TASK FORCE). THE "LIGHT BOX" REMAINED IN SERVICE THROUGH COMPLETION OF PAINTING. WE WILL TEST ADDITIONAL MATERIAL FOR ANTI STICK/ANTI HARDENING PROPERTIES DURING FURTHER TESTING. AFTER COMPLETION OF THE PAINT PROJECT THE "LIGHT BOX" WAS TAKEN TO THE PAINT SHOP AND ONE FOURTH OF THE GLOBE WAS SPRAYED WITH A STRIPPING AGENT, BLISTERING THE PAINT. APPROXIMATELY 15 MINUTES LATER THE BLISTERED PAINT WAS SCRAPED OFF LEAVING A CLEAN NEARLY UNBLEMISHED SURFACE. THE REMAINING THREE FOURTHS OF THE GLOBE WAS CLEANED 3 DAYS LATER WITH THE LIGHT LEFT ON DURING THIS PERIOD. STRIPPER WAS USED AGAIN, BUT ON COATING

THAT HAD COMPLETELY CURED AND WAS MUCH HARDER TO REMOVE. AFTER ABOUT 1 HOUR OF EFFORT THESE SURFACES WERE LEFT WITH AN "ETCHED" APPEARANCE, AND 95% OF THE GLOBE SURFACE BECAME PAINT FREE. THE ILLUMINATION LEVELS REMAINED CONSTANT WITH OUR EARLIER TESTS. SOME OBSERVERS PREFERRED THE ETCHED SURFACE TO THE CLEAN AS IT DIFFUSED THE BRIGHTNESS OF THE BULB.

OVERALL WE BELIEVE THE BEST RESULTS WILL BE OBTAINED BY COVERING THE "LIGHT BOX" WITH A PROTECTIVE FILM, PLUS "BAGGING" IT. NO ADDITIONAL OBSERVATIONS WERE MADE. THIS REPORT WAS SUBMITTED TO PETE JUDT, PAINT SUPERINTENDENT, TODD SHIPYARD FOR REVIEW AND COMMENT.

FIELD TEST II

LIGHT BOX PROTOTYPE – NSRP CONTRACT 96-5-3
LOCATION: TODD SHIPYARD – SEATTLE, WA

DATE: APRIL 28TH – MAY 6TH, 1999

DESCRIPTION OF APPLICATION: INSTALLATION OF LIGHT BOX IN A PASSAGEWAY ON THE 377' TRAWLER, ALASKA OCEAN SEALANDS

ACTIVITY: ABRASIVE BLASTING OF PASSAGE WAY USING COPPER SLAG

COATING: SAME SPACE WITH SIGMA 7402 US ZINC,
4476-1223 INTERMIDIATE EXPOXY PRIMER
5523-7000 FINISH POLYURETHANE TOP COAT

PERSONEL INVOLVED: PETE JUDT – PAINT SUPERINTENDENT

SANDBLASTING WAS SCHEDULED TO BEGIN ON APRIL 28TH. THE LIGHT BOX WAS INSTALLED WITH NO PROTECTION IN THIS SMALL SPACE VIRTUALLY INSURING DIRECT HITS WITH BLAST NOZZEL, EXTENSIVE RICHOCHETE, AND MAXIMUM DUST EXPOSURE.

TODD ALSO INSTALLED THEIR REGULAR DROP LIGHT USED FOR AREA LIGHTING DURING BLASTING. ACCORDING TO REPORTS THE DROP LIGHT FAILED IMMEDIATLEY. THE LIGHT BOX REMAINED THE ONLY AREA

LIGHT AND WAS USED THROUGH THE COMPLETION OF THE PROJECT. THE BLASTER REPORTED THAT THE LEVEL OF LIGHT WAS GOOD AND THAT THEY TOOK NO UNUSUAL PRECAUTIONS TO PROTECT THE LIGHT BOX DURING THE BLASTING

THE GENERAL IMPRESSION REPORTED BY THE OPERATORS WAS CONSISTENT TO THOSE SAMPLED DURING FIELD TEST I.

IN THE PAINTING STAGE WE ASKED THAT THE LIGHT BOX BE "BAGGED", IN THE SAME MANNER THAT TODD "BAGGED" THE REGULAR LIGHTS USED FOR PAINTING. REPORTS FROM THE PAINTERS STATED THAT EVEN WITH THE "BAG" LIGHT LEVELS WERE GOOD.

THIS REPORT VERIFIES THE FOLLOWING:

* MATERIAL USED TO CONTRUCT THE LIGHT BOX PERFORMS WELL UNDER THE HARSH CONDITIONS OF ABRASIVE BLASTING
* THE SEALING SYSTEM WORKED AS DESIGNED, COMPLETELY PREVENTING DUST FROM ENTERING THE INTERIOR OF THE LIGHT BOX - WITHOUT A SEPARATE SEAL
* LIGHTING LEVELS REMAINED GOOD AS DEMONSTRATED BY COMPLETING THE PROJECT USING ONLY THE LIGHT BOX AFTER THE REGULAR DROP LIGHT FAILED.

THE BAGGING OF THE LIGHT DID NOT HAVE A NEGATIVE

IMPACT ON THE LIGHT LEVELS IN THE WORK SPACE

LIGHT BOX WAS PICKED UP FROM TODD ON MAY 13TH, 1999, AND WAS COMPLETELY OPERATIONAL.

THE ACCEPTANCE TO THE PROTOTYPE CAN BEST BE JUDGED BY THE INTEREST TODD SHIPYARD HAS IN USING EXCLUSIVELY A “LIGHT BOX” SYSTEM CONSISTING OF 15 FIXTURES SPACED AT 20’ INTERVALS INSTALLED ALONG THE PERIMETER OF THE USS CAMDEN’S ENCLOSED FANTAIL.

DEVELOPMENT OF FINAL PRODUCT

From conception in December, 1996 to completion in December, 00 the development of the subject lighting system has produced benefits beyond the original concept. These benefits include superior ruggedness, high intensity illumination, and simple maintenance with a minimum of parts. Including the ability to install/leave in place through all phases of construction or maintenance. All these features within a system offering a very competitive price point and a level of safety assurance not previously available in a light, let alone a lighting system.

Every problem was viewed as an opportunity to go beyond the original design concept to produce a benefit to the end user. Every critical component was tested to the most rigorous standards in order to produce a completed assembly that was designed to only enhance the end user experience. Every step in the development of the series 9000 lighting system was designed to extend the envelope in which the light could be used while holding the selling price objective firmly in place. The final result is a light offering a superior level of safety, less maintenance, and easier installation.

This contract has lead to the development of a lighting system capable of revolutionizing the way shipyards light all temporary work spaces. It is intended to increase productivity, while providing superior worker safety and benefiting all at a competitive price.

For more information contact:
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